# HA-5114/883

## Quad, Low Noise, High Performance Uncompensated Operational Amplifier

July 1994

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Low Input Noise Voltage Density at 1kHz. . . 6nV/$\sqrt{Hz}$(Max) 4.3nV/$\sqrt{Hz}$ (Typ)**
- **High Slew Rate. . . . . 12V/µs (Min) 20V/µs (Typ)**
- **Wide Gain Bandwidth Product ($A_{VCL} \geq 10$). . . 40MHz (Typ)**
- **High Open Loop Gain (Full Temp) . . . . . 100kV/V (Min) 250kV/V (Typ)**
- **High CMRR, PSRR (Full Temp). . . . . 86dB (Min) 100dB (Typ)**
- **Low Offset Voltage Drift . . . . . 3µV/°C (Typ)**
- **No Crossover Distortion**
- **Standard Quad Pinout**

### Applications

- **High Quality Audio Preamplifiers**
- **High Q Active Filters**
- **Low Noise Function Generators**
- **Low Distortion Oscillators**
- **Low Noise Comparators**

### Description

Low noise and high performance are key words describing the quad, uncompensated HA-5114/883. This general purpose amplifier offers an array of dynamic specifications including 12V/µs slew rate (min), and 40MHz gain-bandwidth-product for $A_{VCL} \geq 10$. Complementing these outstanding parameters is a very low noise specification of 6nV/$\sqrt{Hz}$ at 1kHz (max).

Fabricated using the Intersil standard high frequency D.I. process, these operational amplifiers also offer excellent input specifications such as 2.5mV (max) offset voltage and 75nA (max) offset current. Complementing these specifications are 100dB (min) open loop gain and 55dB channel separation (min). Economically, HA-5114/883 also consumes a very modest amount of power (225mW/ package), while also saving board space and cost.

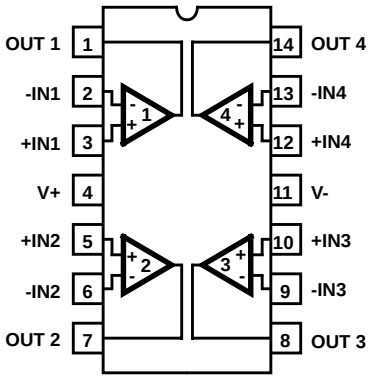
This impressive combination of features make this amplifier ideally suited for designs ranging from audio amplifiers and active filters to the most demanding signal conditioning and instrumentation circuits.

### Ordering Information

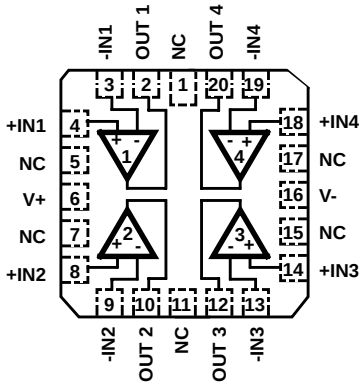
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-5114/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA4-5114/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

**HA-5114/883**
**(CERDIP)**
TOP VIEW




**HA-5114/883**
**(CLCC)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.





File Number **511015-883**

File Number **3712**

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals . . . . . 40V
Differential Input Voltage . . . . . 7V
Voltage at Either Input Terminal . . . . . V+ to V-
Peak Output Current. . . . . Indefinite
(One Amplifier Shorted to Ground)
Junction Temperature ($T_J$) . . . . . +175°C
Storage Temperature Range . . . . . -65°C to +150°C
ESD Rating. . . . . <2000V
Lead Temperature (Soldering 10s) . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 75°C/W | 20°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |

Package Power Dissipation Limit at +75°C
CerDIP Package . . . . . 1.33W
Ceramic LCC Package . . . . . 1.54W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . 13.3mW/°C
Ceramic LCC Package . . . . . 15.4mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range . . . . . -55°C to +125°C
Operating Supply Voltage . . . . . ±5V to ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM} = 0V$ | 1 | +25°C | -2.5 | 2.5 | mV |
| | | | 2, 3 | +125°C, -55°C | -3.0 | 3.0 | mV |
| Input Bias Current | $+I_B$ | $V_{CM} = 0V$, $+R_S = 10k\Omega$, $-R_S = 100\Omega$ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| | $-I_B$ | $V_{CM} = 0V$, $+R_S = 100\Omega$, $-R_S = 10k\Omega$ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM} = 0V$, $+R_S = 10k\Omega$, $-R_S = 10k\Omega$ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | +12 | - | V |
| | | | 2, 3 | +125°C, -55°C | +12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT} = 0V$ and +10V, $R_L = 2k\Omega$ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT} = 0V$ and -10V, $R_L = 2k\Omega$ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM} = +5V$, V+ = +10V, V- = -20V, $V_{OUT} = -5V$ | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -CMRR | $\Delta V_{CM} = -5V$, V+ = +20V, V- = -10V, $V_{OUT} = +5V$ | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 2kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 2kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+V_{OUT2}$ | $R_L$ = 10kΩ | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | $-V_{OUT2}$ | $R_L$ = 10kΩ | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -5V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +5V | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 6.5 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 7.5 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -6.5 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -7.5 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +10V, V- = -15V V+ = +20V, V- = -15V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -10V V+ = +15V, V- = -20V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Parameters in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = 10V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 250 | - | kΩ |
| Input Noise Voltage | $E_N$ | $R_S$ = 20Ω, $f_O$ = 1000Hz | 1 | +25°C | - | 6 | $nV/\sqrt{Hz}$ |
| Input Noise Current | $I_N$ | $R_S$ = 2MΩ, $f_O$ = 1000Hz | 1 | +25°C | - | 3 | $pA/\sqrt{Hz}$ |
| Gain Bandwidth Product | GBWP | $V_O$ = 200mV, $f_O$ = 30kHz | 1 | +25°C | 34 | - | MHz |
| | | $V_O$ = 200mV, $f_O$ = 1MHz | 1 | +25°C | 40 | - | MHz |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = 10V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V | 1 | +25°C | 12 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V | 1 | +25°C | 12 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 191 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 2kΩ, $C_L$ = 50pF | 1 | -55°C to +125°C | 10 | - | V/V |
| Rise and Fall Time | $t_R$ | $V_{OUT}$ = 0V to +200mV | 1, 4 | +25°C | - | 100 | ns |
| | $t_F$ | $V_{OUT}$ = 0V to -200mV | 1, 4 | +25°C | - | 100 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0V to +200mV | 1 | +25°C | - | 40 | % |
| | -OS | $V_{OUT}$ = 0V to -200mV | 1 | +25°C | - | 40 | % |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 270 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 225 | mW |
| Channel Separation | CS | $R_S$ = 1kΩ, $A_{VCL}$ = 100V/V, $V_{IN}$ = 100m$V_{PEAK}$ at 10kHz Referred to Input | 1 | +25°C | 55 | - | dB |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
99.6 x 95.3 x 19 mils ± 1 mils
2530 x 2420 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
1.43 x $10^5$A/$cm^2$ at 10mA

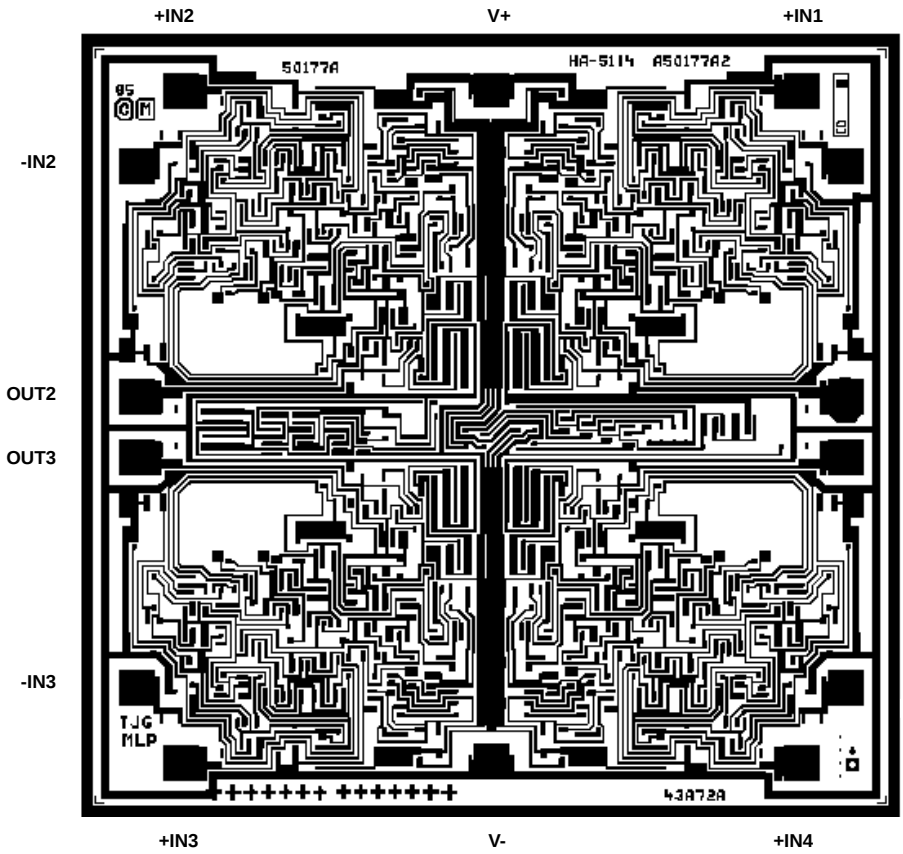
**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:** 175

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

**HA-5114/883**

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